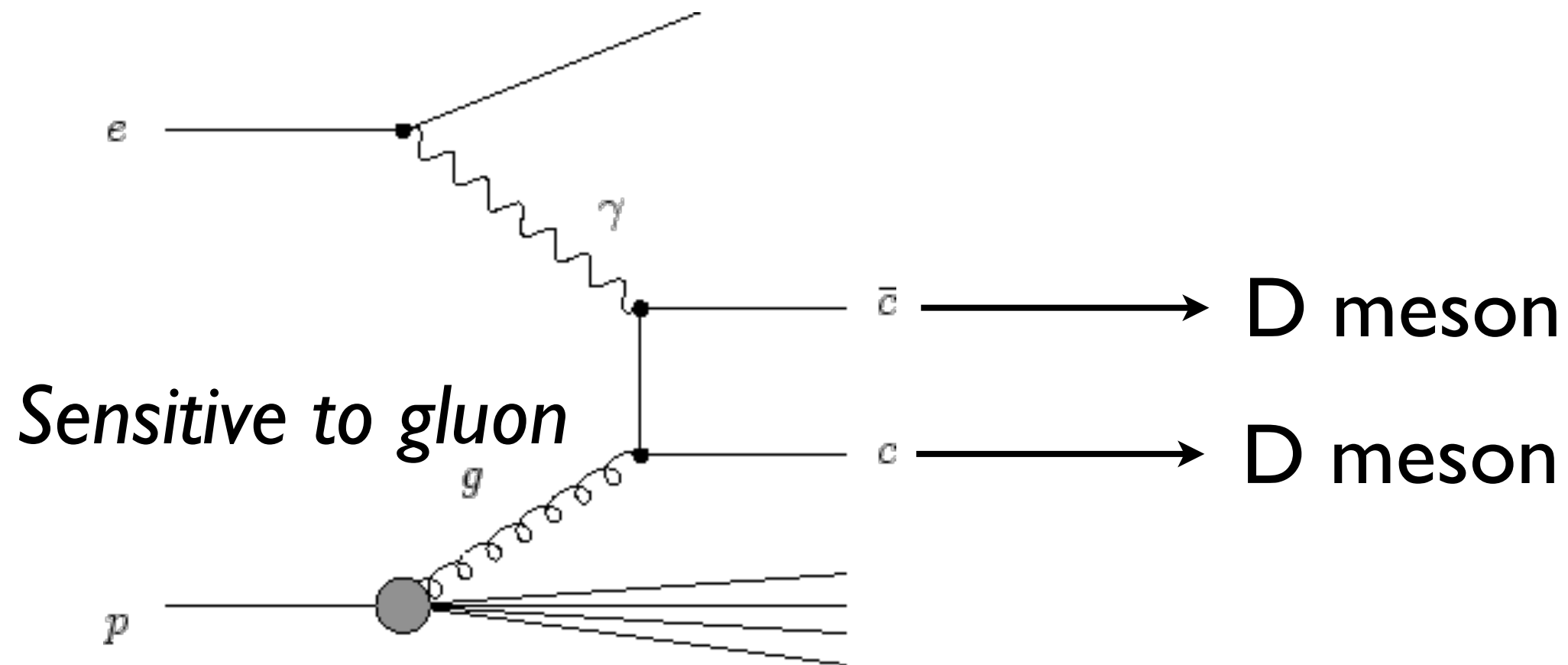


# Gluon Sivers with D0s

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EIC taskforce meeting  
Thur 10th Nov 2011

# D meson pairs

$$\gamma^* N^\uparrow \rightarrow H_1(k_1) + H_2(k_2) + X$$



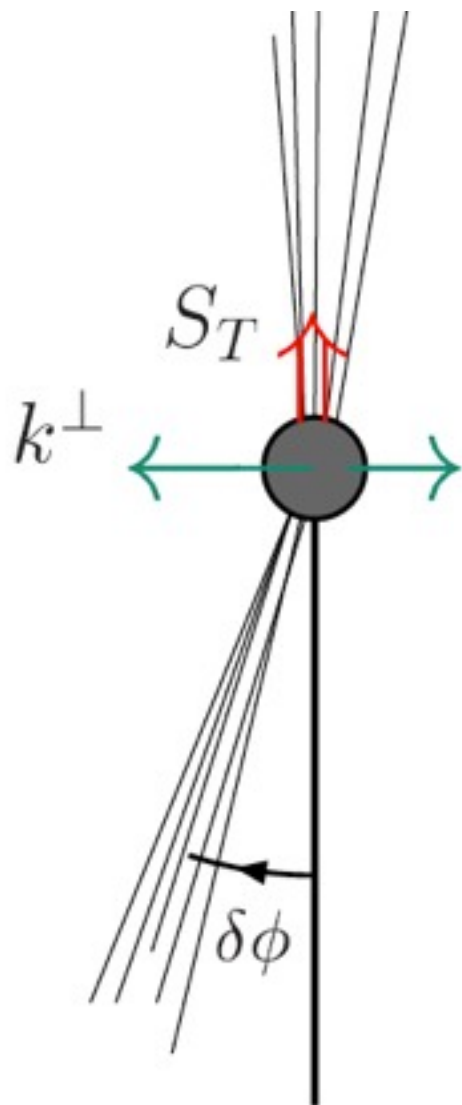
# Accessing gluon Sivers

See INT report

$$\mathbf{k}_\perp = \mathbf{k}_{1T} + \mathbf{k}_{2T}, \quad \mathbf{P}_T = (\mathbf{k}_{1T} - \mathbf{k}_{2T})/2$$

$$A(k'_\perp, \phi_{S k'}) = \frac{d\sigma(k'_\perp, \phi_{S k'}) - d\sigma(k'_\perp, \phi_{S k'} + \pi)}{d\sigma(k'_\perp, \phi_{S k'}) + d\sigma(k'_\perp, \phi_{S k'} + \pi)}$$

' indicates hadronic, not partonic, variable



- Introduce spin,  $S$ :  $\Rightarrow$  asymmetry.
- $\phi_{S k'}$  azimuthal angle between  $S_\perp$  and  $k_\perp$ .
- Interested in when  $p_T$  imbalance is small:  
 $k_\perp \ll P_T$

# Asymmetry

- From INT report

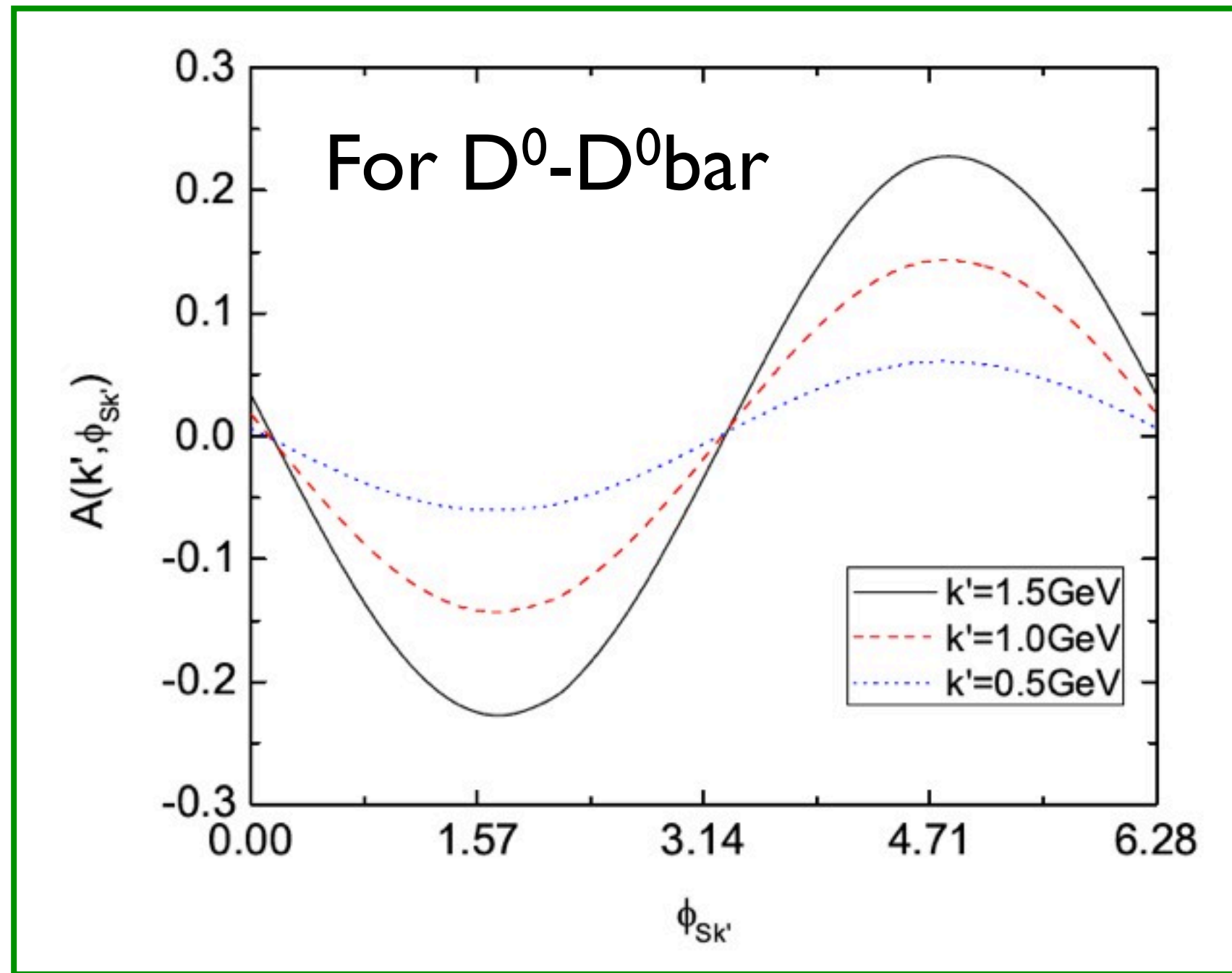
- **Cautions!**

- $z_1 = z_2 = 0.3$

- $W = 100 \text{ GeV}$

- $Q^2 = 16 \text{ GeV}^2$

- $5 < P_T' < 40 \text{ GeV}$



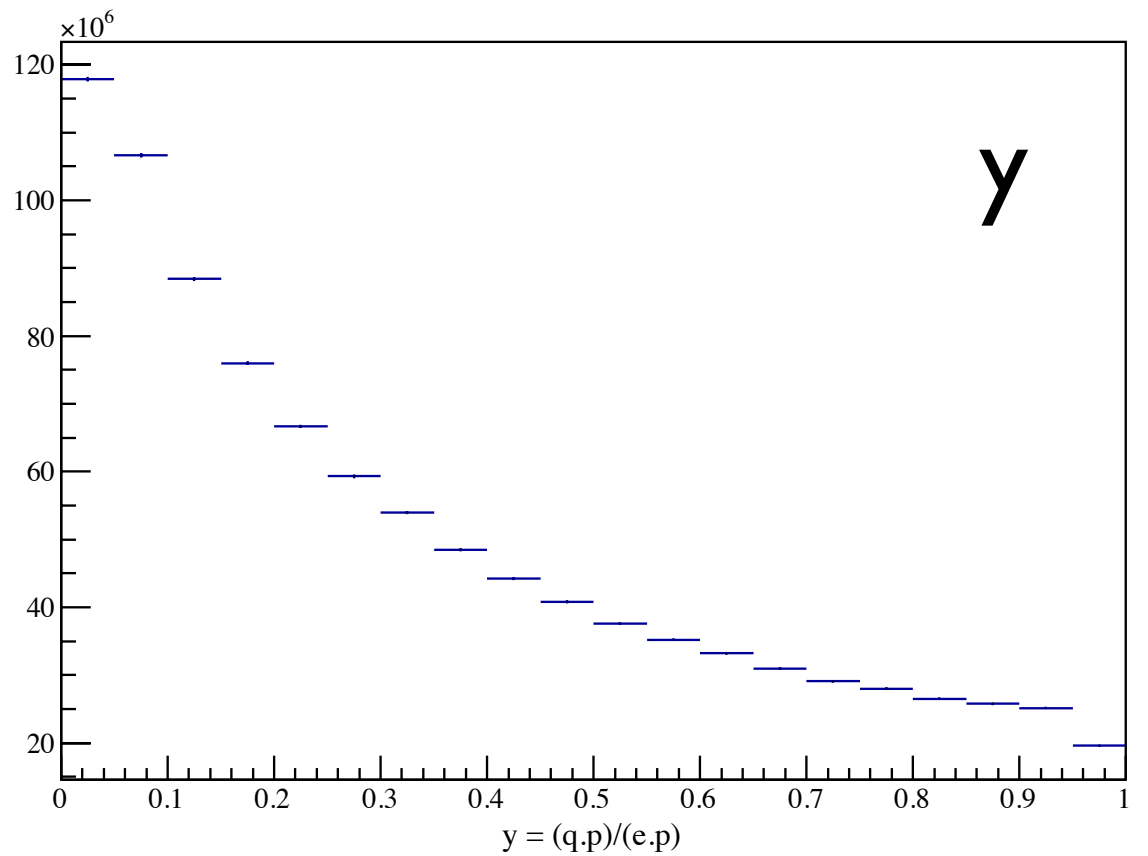
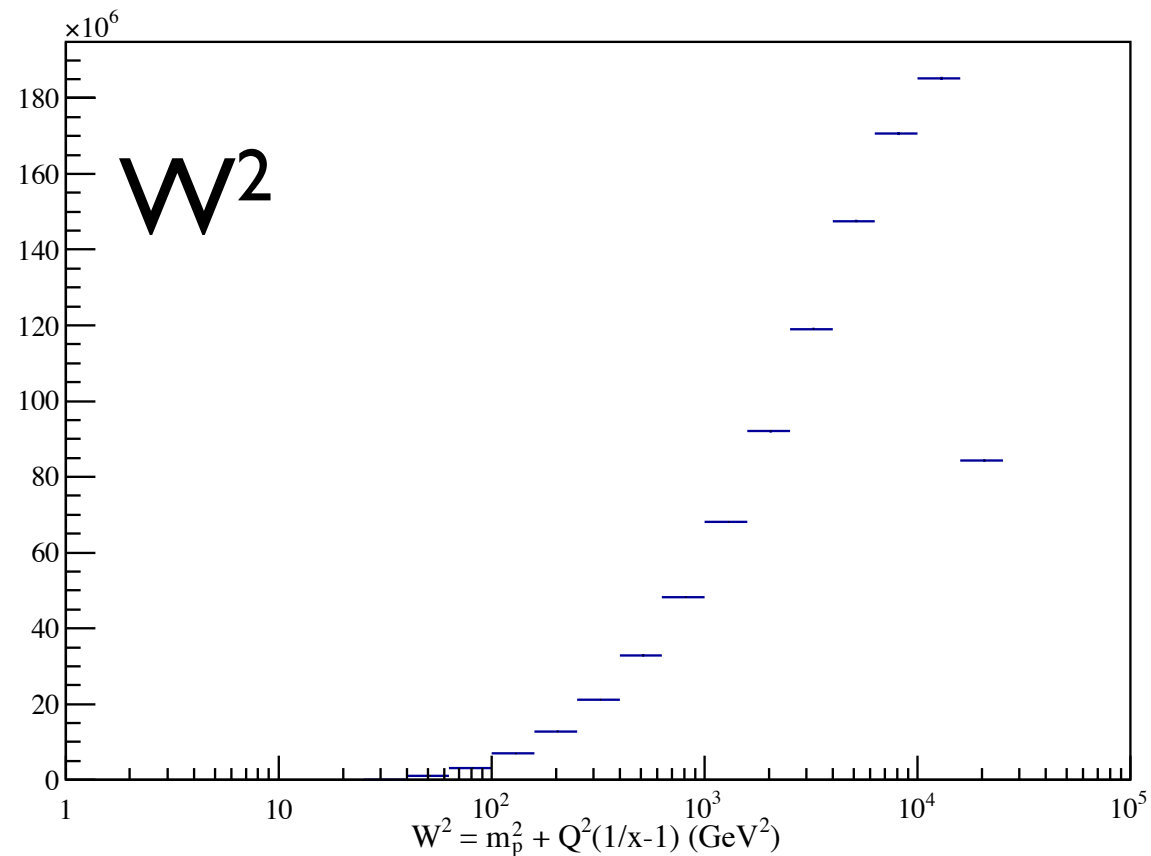
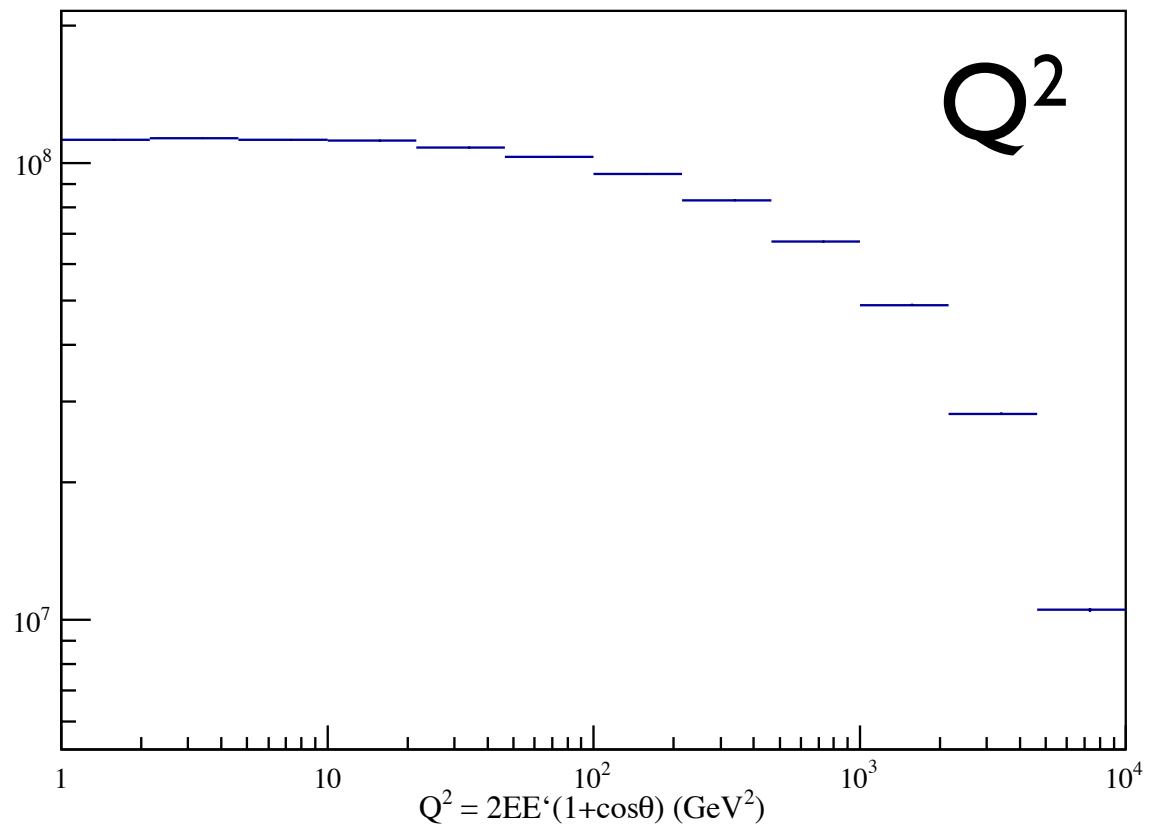
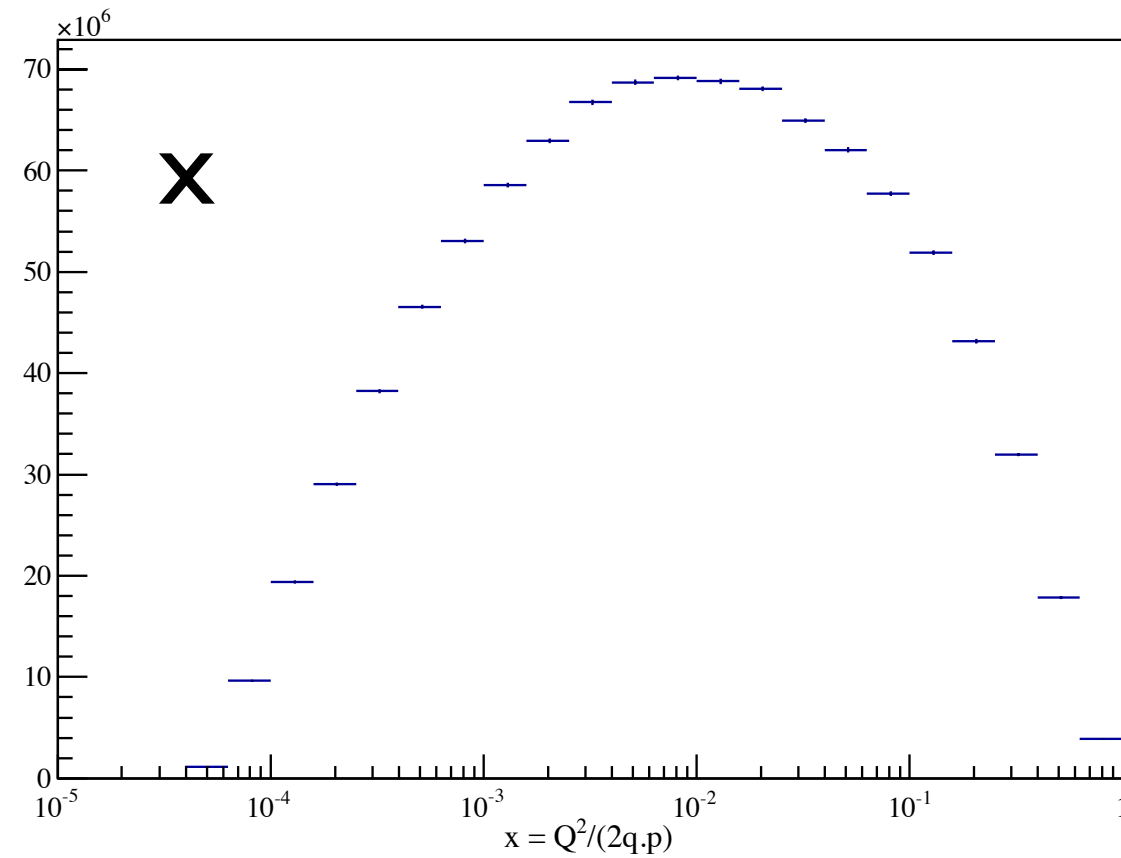
NOT going to happen at an EIC...  
... but Feng says they don't need to be  
this high anyway.

# PYTHIA

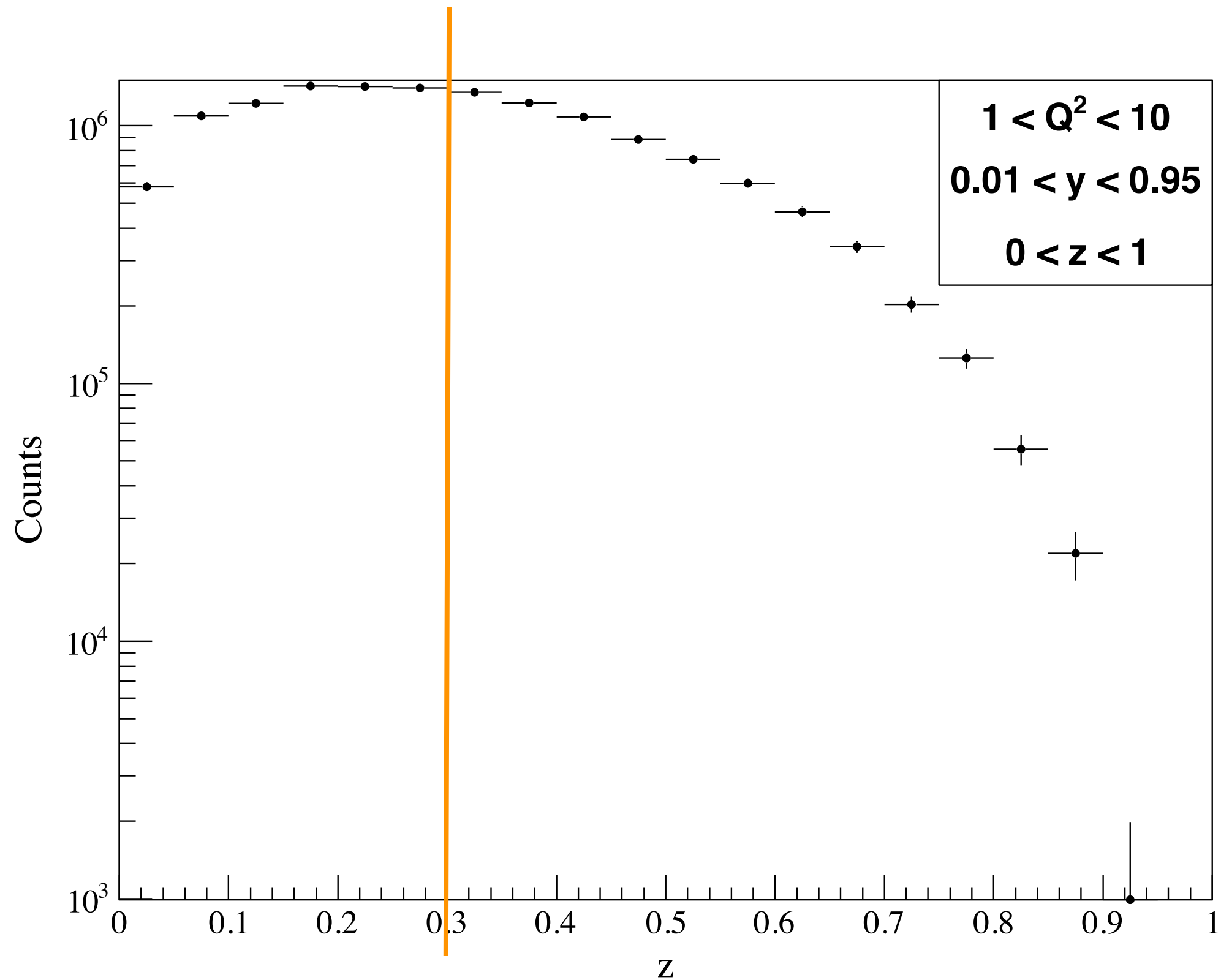
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- Study potential using PYTHIA simulation
- EIC PYTHIA installation (v6.4)
- 20 x 250 GeV.
- charm-only files, 1M events,  $Q^2 > 1$
- Weight counts to scale for  $10 \text{ fb}^{-1}$ .

# Event kinematics

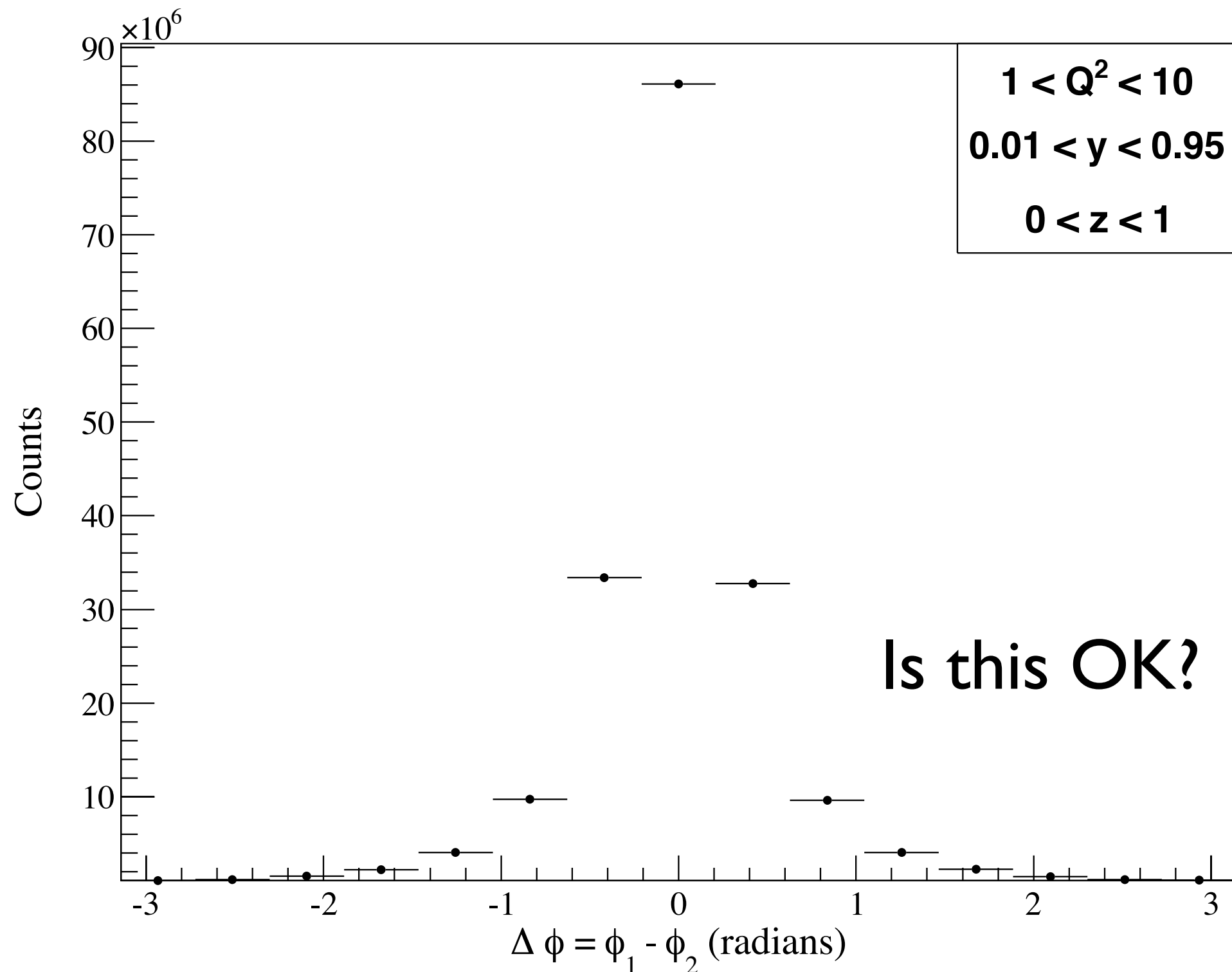


# D0(bar)



# Correlation between c quark and D0

- Associate  $c \rightarrow (\text{string} \rightarrow D^0 + X)$  with the  $D^0$ .





# Detecting $D^0$

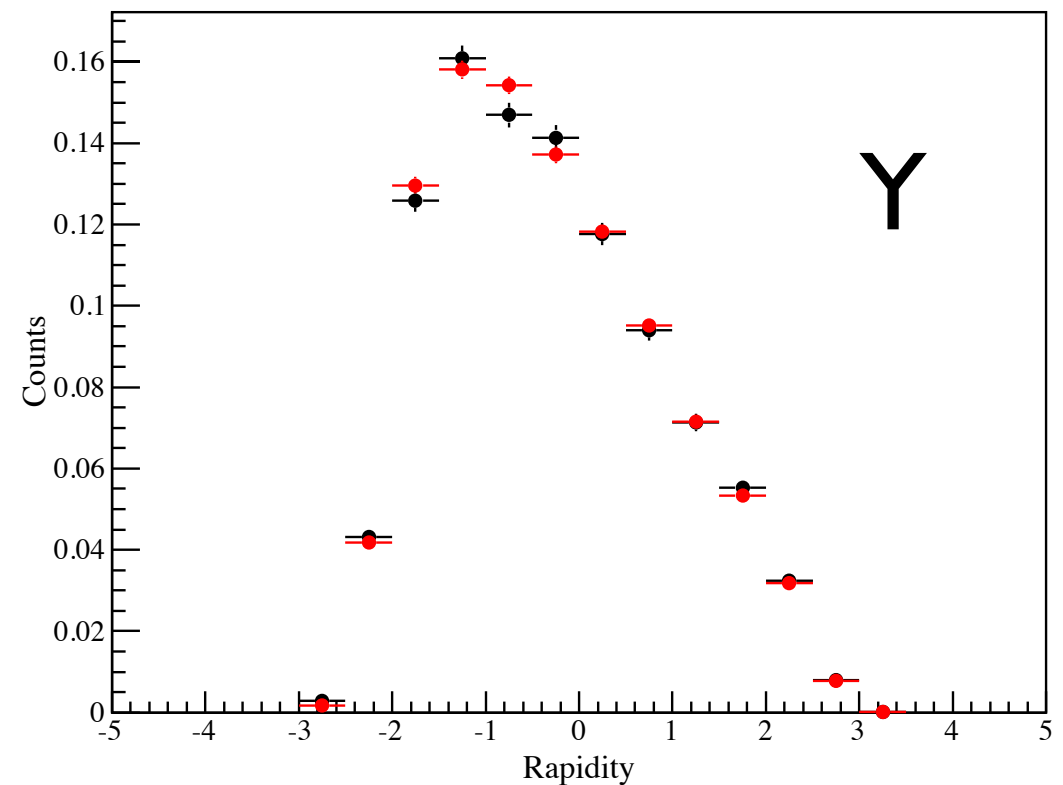
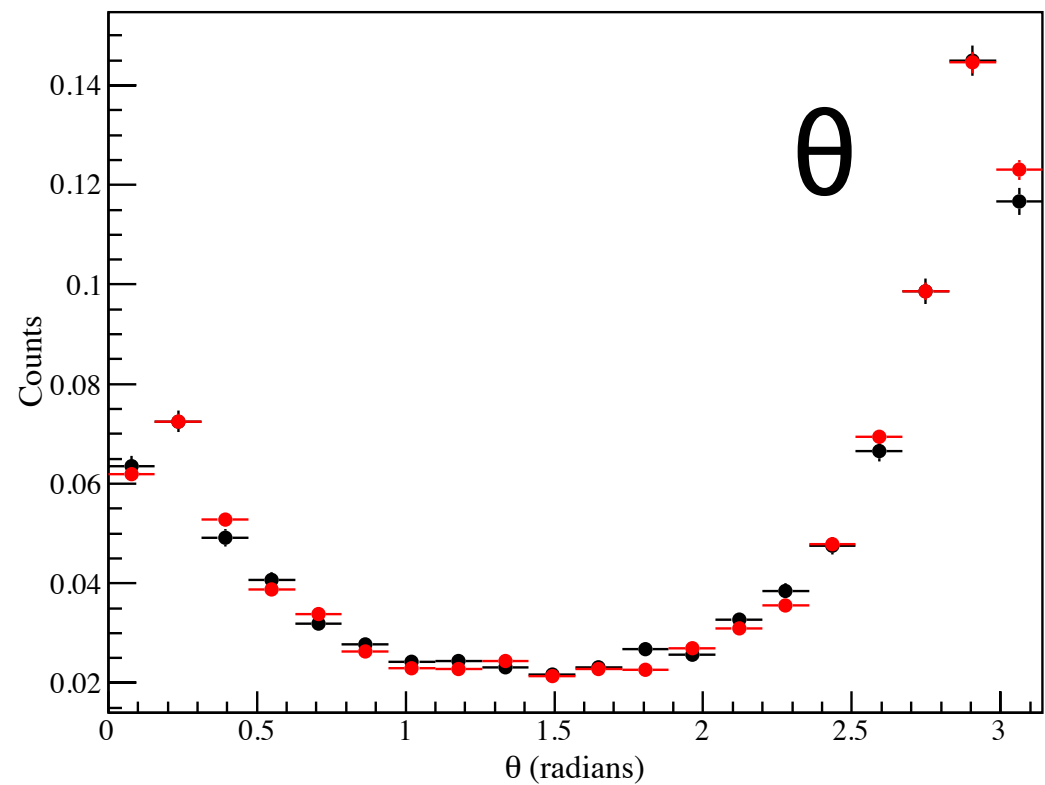
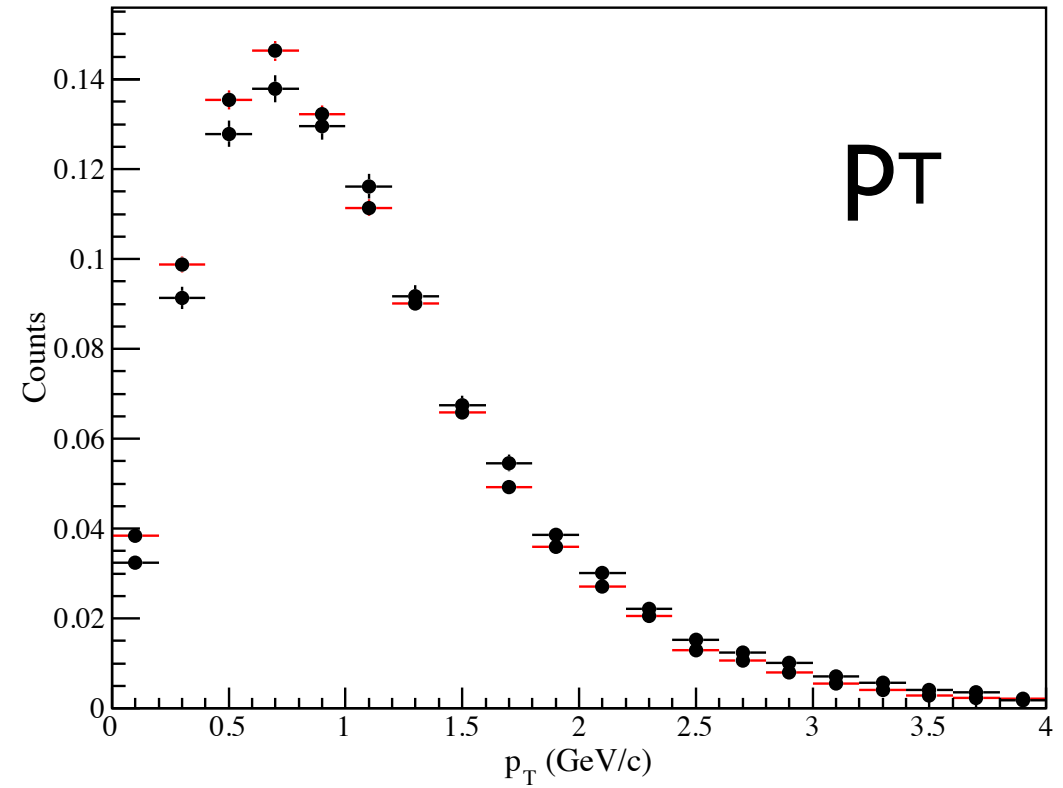
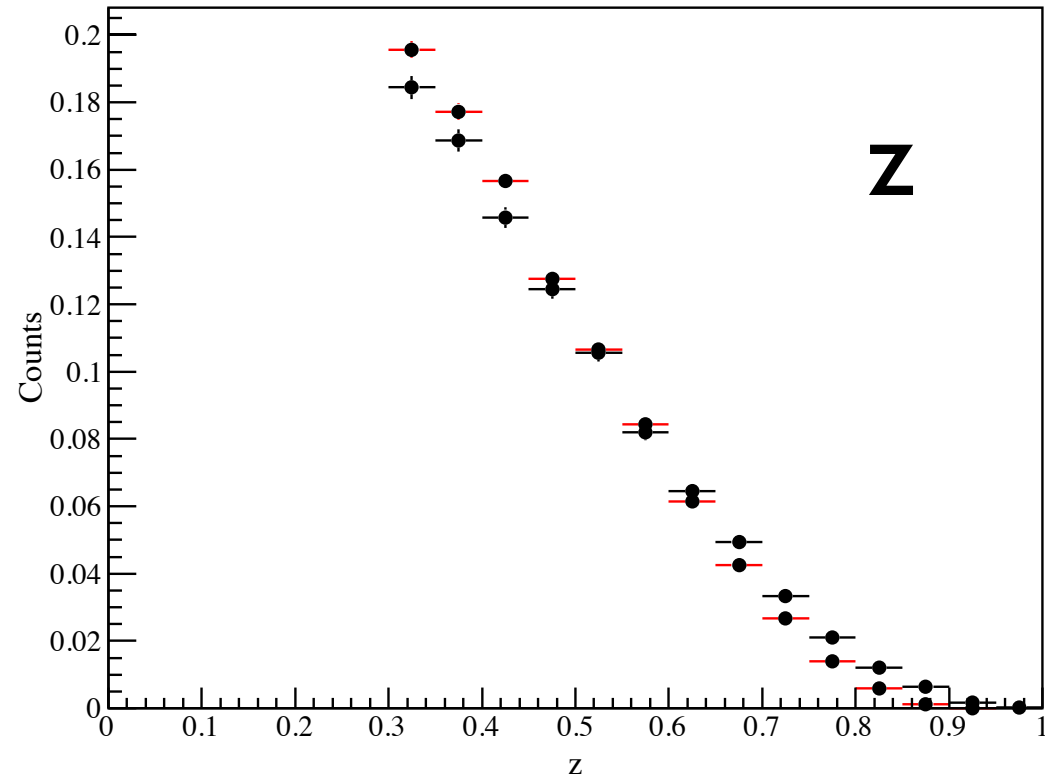
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- $D^0$  has many decay channels, mostly
  - ▶ semi-leptonic (inc. neutrino)
  - ▶ multi-hadron (3+ products) - hard to reconstruct
- Most promising:  $D^0 \rightarrow \pi K$ 
  - ▶ Branching ratio 3.87 %

# Direct D0

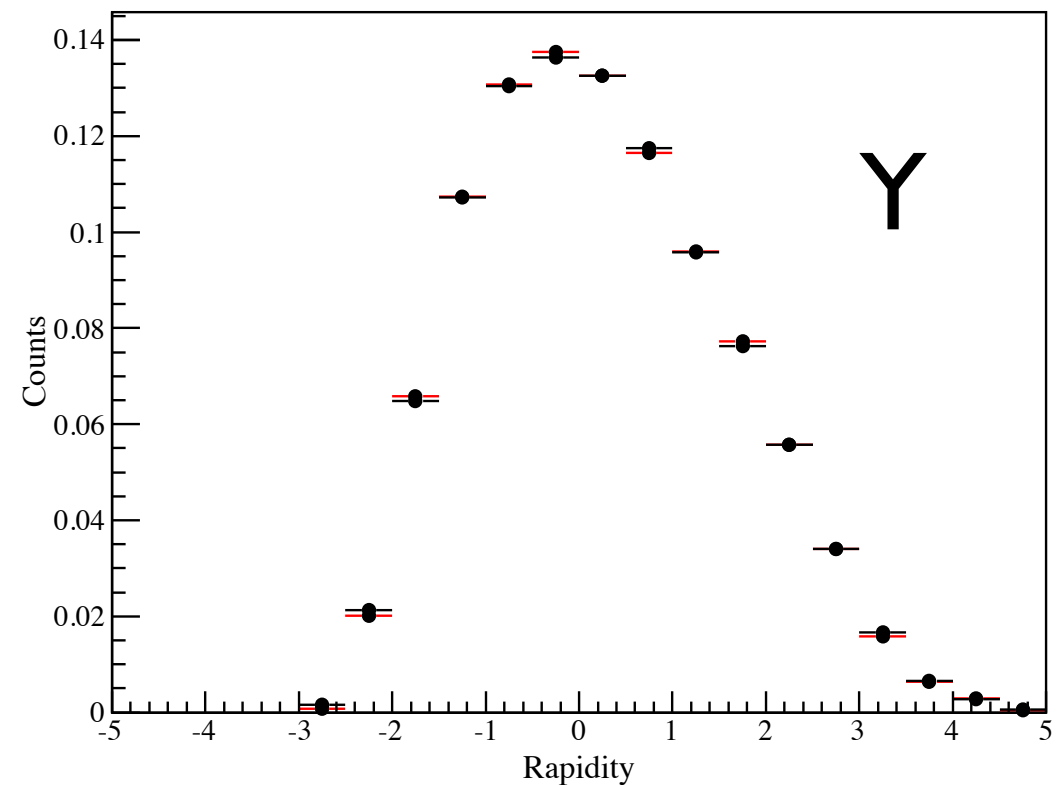
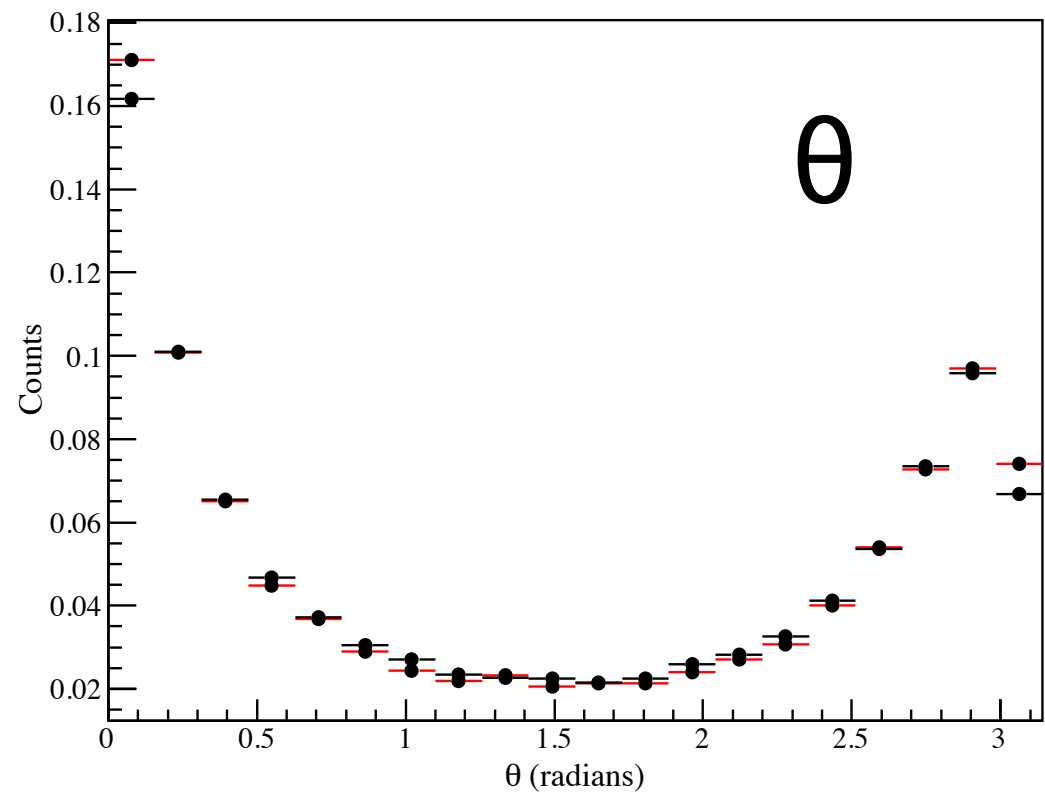
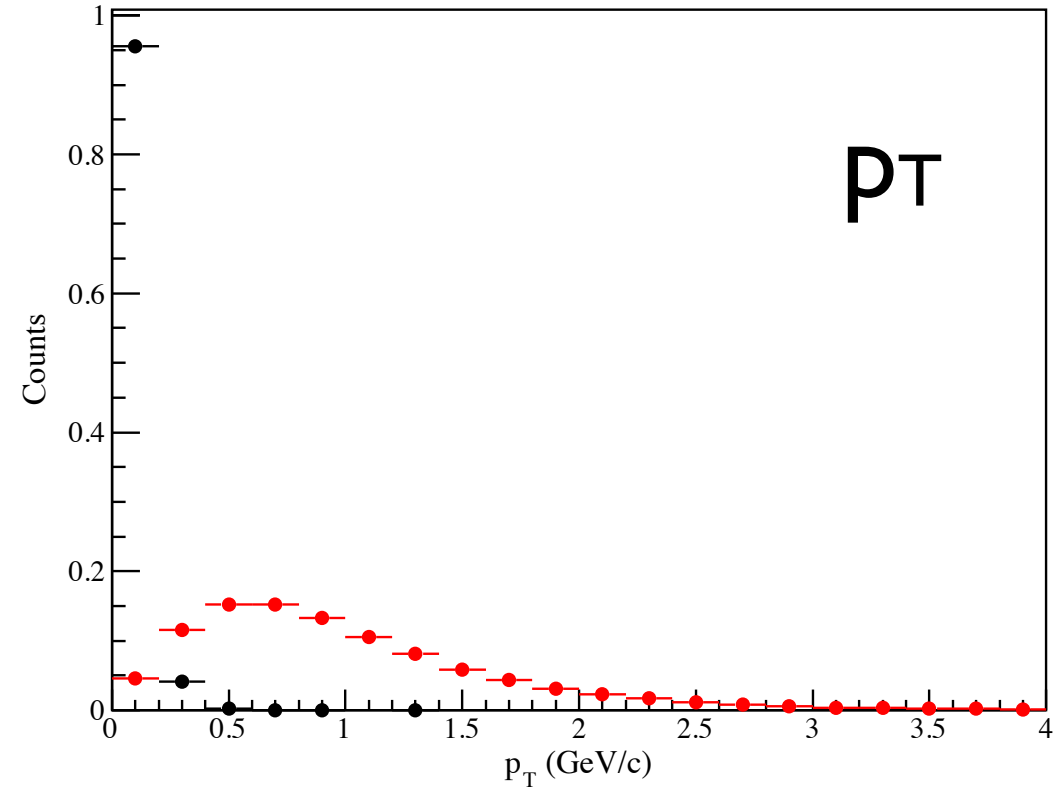
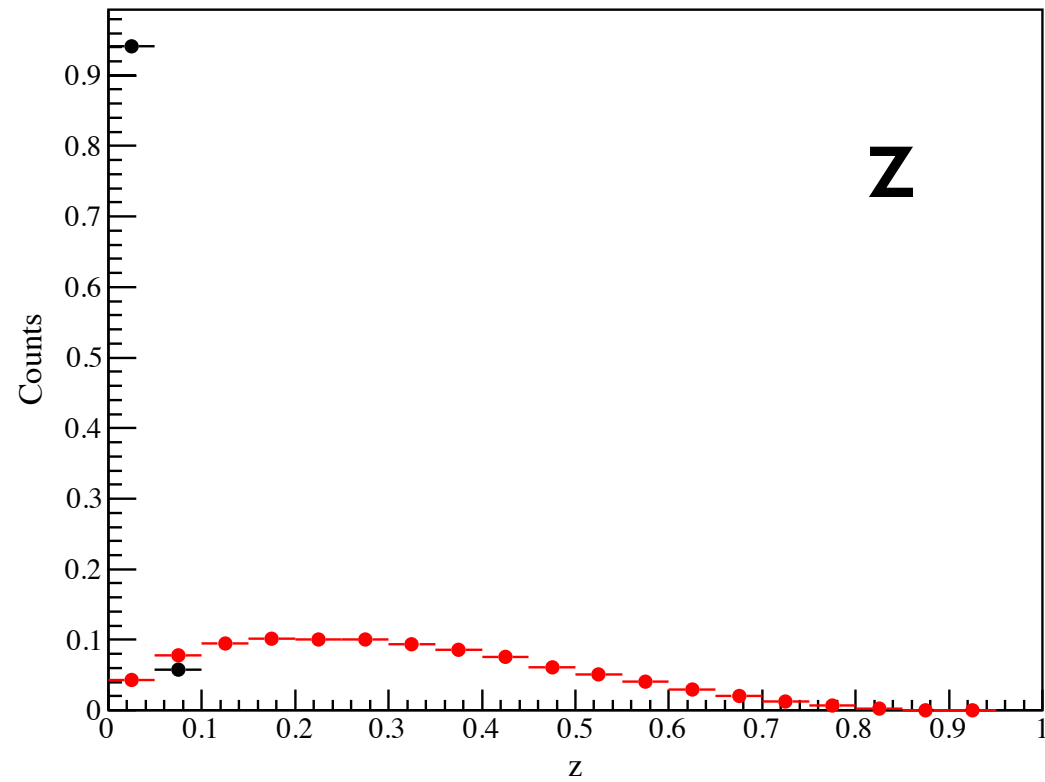
## D0 from $D^{*\pm}$

$$D^{*\pm} \rightarrow D^0 \pi?$$



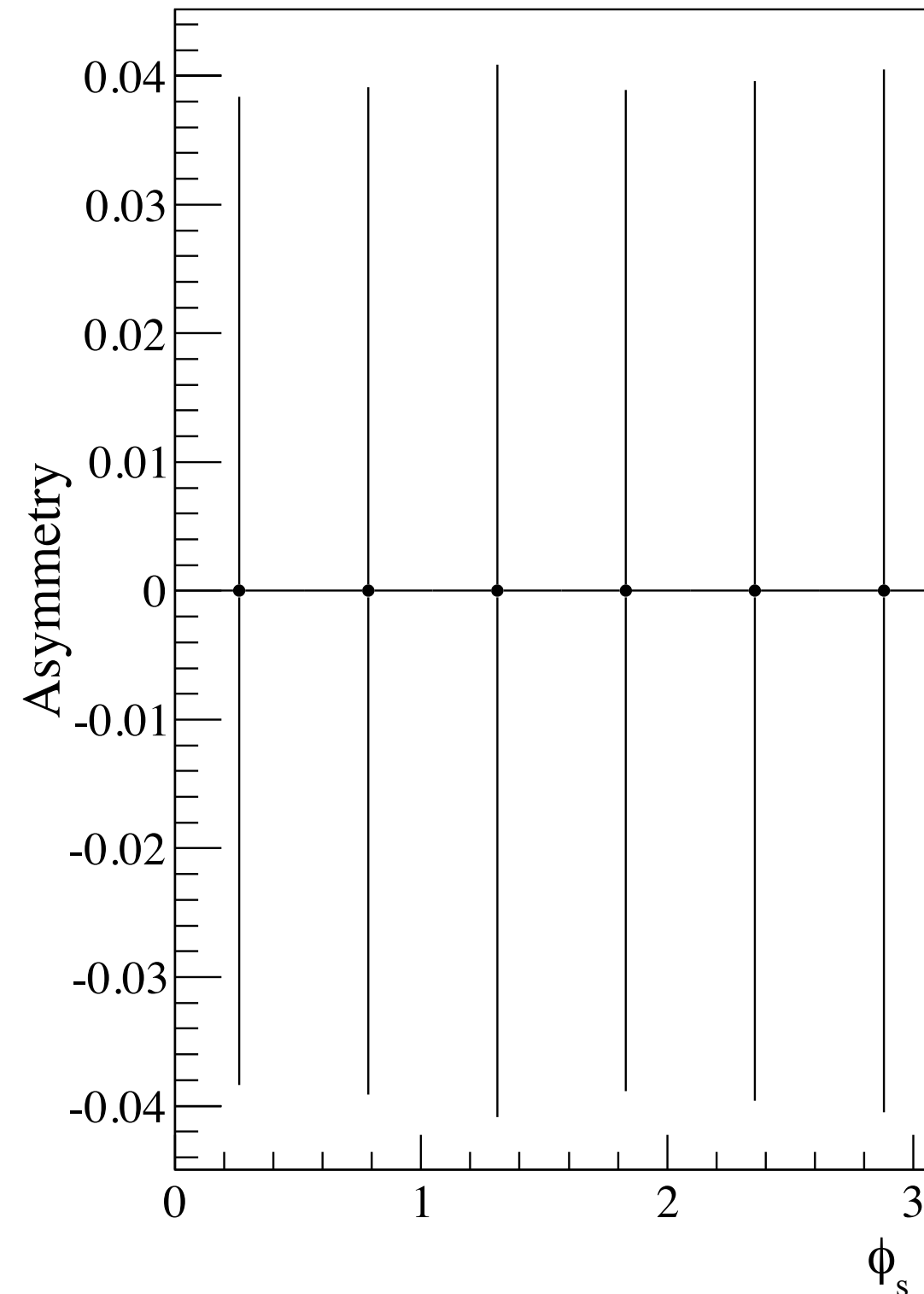
$\pi$  from  $D^{*\pm}$   
 $D^0$  from  $D^{*\pm}$

$D^{*\pm} \rightarrow D^0 \pi?$



# Asymmetry uncertainty

- Use loose kinematic cuts
  - $Q^2 > 1$ ,  $0.01 < y < 0.95$ ,  $z_{D0} > 0.3$ .
  - Is  $Q^2 > 0.1$  OK?
- **20 x 250 GeV** (i.e. later-stage EIC).
- Scale counts for **10 fb<sup>-1</sup>**
- Just use  $1/\sqrt{N}$  per bin
  - ~few % per bin in  $\phi_s$ .



# What's missing?

- Statistical prediction with:
  - Binning in  $k_{\perp}$ .
  - Cut on  $k_{\perp}/P_T$ .
- Detector acceptance cuts.
- Effect of smearing.

